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SOLAR MANUFACTURING CORPORATION

CAPACITOR ANALYZER AND RESISTANCE BRIDGE

Models CC 1-60 and CB 1-60

Power Line Connections

The Solar Capacitor Analyzer Models CC 1-60 and CB 1-60 are designed for use on 110 volts, 50-60 cycles. They should not be connected to power lines which supply other voltages or frequencies.

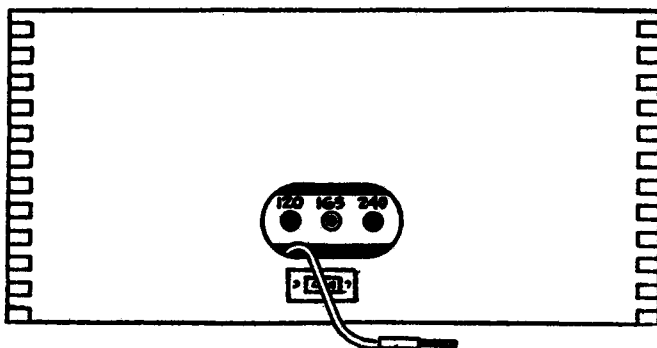
To place Analyzer in operation, on the Model CC, remove line cord from packing tube in instrument cover, then plug one end of line cord into the receptacle in back of the cabinet, and connect other end to power line. On the Model CB, one end of the line cord is permanently connected to the instrument. Proceed with measurements according to instructions described in this manual.

Models CC 2-U and CB 2-U

Power Line Connections

The Solar Capacitor Analyzer Models CC 2-U and CB 2-U are universal instruments which can be operated from power lines rated at 120, 165 or 240 volts, 25 to 60 cycles.

To place Analyzer in operation remove the small metal plate in the back of the cabinet and insert phone tip in the hole corresponding with the available line voltage. The illustration shown below describes the procedure.



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OPERATING MANUAL

SOLAR CAPACITOR ANALYZER

and Resistance Bridge

Type CC 1-60 and CB 1-60	110 Volts	50-60 Cycles
Type CC 2-U and CB 2-U	120, 165, 240 Volts	25-60 Cycles

GENERAL

During the past few years the performance requirements of radio receivers have been reaching high levels which can only be maintained by the use of high quality component parts. These parts, especially condensers and resistors, must have satisfactory electrical characteristics to perform their designated functions properly, if satisfactory results are to be obtained from receivers.

Condensers have a detrimental effect on reception, long before they become permanently defective. The problem of determining the quality or operating efficiency of a condenser requires a complete measurement of its capacity, leakage-resistance and power factor. Motor starting A.C. electrolytic condensers used in connection with fractional horse power motors present a somewhat similar service problem.

The Solar Capacitor Analyzers meet the requirements of radio service men and engineers for inexpensive instruments which will accurately determine the important electrical characteristics of all types of electrolytic, paper, mica, trimmer and air condensers.

Condensers may be tested for capacity, leakage, opens, shorts, intermittent operation and power factor.

Accurately calibrated markings on several color-coded scales are provided for convenient measurement of capacity and resistance. These tests are made on a Wien Bridge with five direct reading ranges on the Model CB and six ranges on the CC. The power factor of electrolytic condensers can be read directly from a scale which is calibrated zero to 50% power factor. The capacity range of the Model CB is from .00001 mfd. to 70 mfd., and the resistance

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range is from 50 ohms to 2,000,000 ohms. On the Model CC an extra capacity scale up to 800 mfd. is included which permits testing of motor starting condensers for capacity and power factor.

The advantages of a bridge for capacity and resistance measurements are well known. Some of these advantages include independence of reading from line voltage variations, and high degree of accuracy.

The use of a bridge circuit in an inexpensive instrument of this type has been made possible by the unusual detector arrangement employed. This detector arrangement consists of a highly sensitive 6E5 cathode ray tube connected across the output of the bridge.

The leakage test part of the equipment consists of a D.C. power supply and a Neon lamp. A switch is provided with voltage settings covering practically all electrolytic and paper condensers which may be encountered in the field.

For leakage test of paper condensers, this device is particularly useful because of its high sensitivity. In many places in the radio receiver, such as for the gridplate coupling condenser, the insulation resistance is of considerable importance, and the sensitivity of this device is entirely adequate for that purpose. The instrument will be found useful as well for tests of insulating material.

Certain electrolytic condensers end their useful life by losing capacity or by developing a high resistance contact at the anode tab, due to corrosion. These defects will not show up on a direct leakage test, but may be unerringly detected by capacity and power factor tests as provided for in this test instrument.

The instruction card furnished with this instrument and the instructions to follow, specify certain limits which have been set in connection with the leakage and capacity measurements to be used as a guide in judging satisfactory condensers. These limits have been chosen arbitrarily on the basis of our experience with condensers made for use in radio receivers, and, in general, condensers which meet these requirements will be found satisfactory in operation, while those rejected will interfere with satisfactory operation.

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On the other hand, it is well known that condensers used in certain specific circuit arrangements may be more, or possibly less critical with respect to their leakage, capacity, or power factor requirements than our limits indicate. These exceptional cases can be handled best by intelligent use of this test instrument after careful and thorough study of all the accompanying instructions.

While this instrument will make the required measurements quickly and accurately, some discretion must be used in the application of the measurements for determining whether a condenser is satisfactory for actual use in any specific circuit.

CAUTION: Do not remove or loosen the bridge control knob, since this is carefully set during calibration at the factory.

OPERATING INSTRUCTIONS

Insert any standard make of 6E5 and "80" tubes into the respective sockets, as marked on the metal panel of the Model CC. Insert any standard make of 6E5 and "IV" tubes in the sockets of the Model CB as marked on the panel. Place shield over 6E5 tube. Then connect line plug to a power outlet of the proper voltage and frequency, as specified on the instruction card and on the panel of the instrument.

Snap the toggle switch on the left side of the panel to the "ON" position and rotate "S" to position "O". This is the neutral position and no voltage is applied to the testing terminals. Consequently, connections can be made without danger of shock. After allowing about one minute for the tubes to heat up, proceed with testing as described below, the leakage test being made before for capacity:

LEAKAGE TEST ON PAPER CONDENSERS

Plug tips of the test leads into the jacks marked "COND". Set Power Factor Control to "Paper-Mica". Place capacity control at "SHORT" and then connect condenser securely to clips. Adjust "S" to the position shown in the chart for the capacitor being tested and observe the indication given by the Neon glow tube marked "Leakage" after several seconds.

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MICA AND PAPER CONDENSERS

Approximate Capacity Rating	Setting for Power Factor Control	Attach Cond. to Terminals	Setting for Capacity Control	Model CB Setting for Switch "S"	Model CC Setting for Switch "S"
0- 1.0 mfd.	Paper-Mica	Cond.	Short	5	4
1.0-25. mfd.	Paper-Mica	Cond.	Short	3	2

SATISFACTORY—No glow or periodic flashes not exceeding a rate of once per second.

SHORTED—A steady glow which is not extinguished after several seconds. (Replace condenser).

LEAKY—A steady dull glow or flashes exceeding a rate of one per second. (Replace condenser).

INTERMITTENT—This type of defect will be indicated usually as shorted on the leakage test. A better indication of intermittent condensers is given on the capacity test. (Replace condenser).

OPEN—The capacity test will detect all open condensers.

The leakage test for mica, oil and all solid dielectric condensers is the same as the leakage test of paper condensers.

The leakage of a condenser which will give one flash per second or less, of the "leakage Neon lamp," will be found satisfactory for most applications with the exception of condensers used for coupling from the plate of one tube to the grid of the next, as shown in Fig. 1 below.

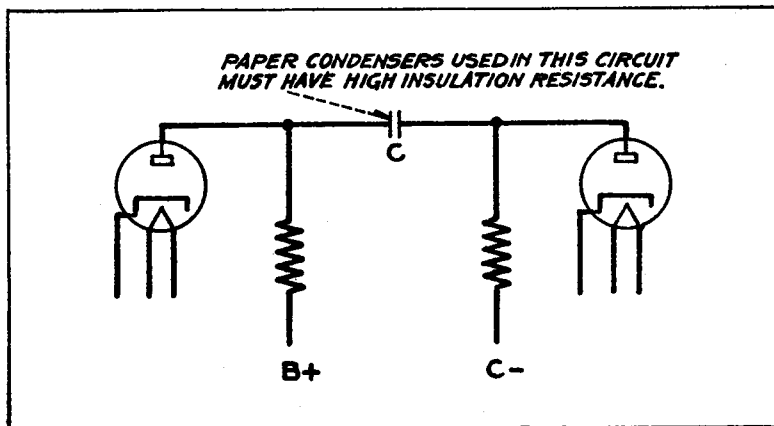


Fig. 1

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This arrangement is widely used in radio receivers in the A.F. amplifier and a leaky condenser in this position will result in a loss in bias voltage on the grid of the second tube. Coupling condensers of this type should be rejected unless the flashes under test occur less than once every four seconds.

Condensers having fibre or similar terminal strips often show considerable leakage between terminals across the fibre. When these condensers are used in circuits where the leakage itself is not of importance and the leakage is known to be across the terminal strip rather than through the section, there is, of course, no reason for rejection. Leakage through terminal strips may be detected as described under the heading of "Miscellaneous Applications" described on one of the following pages.

For many condensers, particularly those used across low voltage circuits, 25 volts or less, the insulation resistance may drop to values such that the "leakage" Neon lamp will flash twice each second before the condensers may be considered unsatisfactory.

LEAKAGE TEST ON ELECTROLYTIC CONDENSERS

After adjusting "S" to position "O", connect test leads across "COND", placing the red lead in the red tip jack. Rotate capacity control to "Short", place power factor control at Electrolytic and connect the positive terminal of the electrolytic condenser to the red test lead and the negative to the black test lead. For non-polarized condensers such as AC or motor starting types make two leakage tests. First connect leads to condenser, disregarding polarity, and make test according to chart. Then reverse connections and make similar test. Adjust "S" as described below and observe indications given by the Neon glow tube marked "leakage".

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ELECTROLYTIC CONDENSERS

(Observe Polarity)

Positive - red — Negative - Black

Working Volts	Attach Cond. to Terminals	Setting for Power Factor Control	Setting for Capacity Control	Model CB Setting for Switch "S"	Model CC Setting for Switch "S"
20-100	Cond.	Electrolytic	Short	1	1
100-200	Cond.	Electrolytic	Short	2	1
200-300	Cond.	Electrolytic	Short	3	2
300-400	Cond.	Electrolytic	Short	4	2
400-525	Cond.	Electrolytic	Short	5	3

SATISFACTORY—A dull red glow which is extinguished within one minute. If condensers have not been used for several weeks, allow them to remain on test for at least five minutes. If the glow is extinguished in this time, the condenser is satisfactory.

SHORTED—A bright red glow which does not diminish or extinguish after several minutes. (Replace condenser).

HIGH LEAKAGE—A glow which does not dim appreciably in one minute or is not totally extinguished in five minutes. (Replace condenser).

INTERMITTENT—A glow which dims or extinguishes entirely and then increases in brilliancy or glows again after a few seconds. However, the capacity test gives a better indication of intermittent condensers. (Replace condenser).

Electrolytic condensers which have been out of service for long periods of time may require longer than five minutes for the leakage to drop below the required value to extinguish the "Leakage" Neon lamp. Test of such condensers may be speeded up by turning the switch "S" to the highest voltage position, tap "4" on the Model CC and tap "5" on the Model CB, for short periods of time until the condenser re-forms. This can be done without danger to the condenser under test by switching back to the correct tap every 30 seconds or so to check whether the leakage has dropped within the acceptance limit.

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CAPACITY AND POWER FACTOR MEASUREMENTS OF PAPER, MICA, ELECTROLYTIC AND AIR CONDENSERS

After adjusting "S" to position "O" plug the tips of the test leads into the jacks marked "COND" and connect condenser to test clips. Then place power factor control and switch "S" in positions corresponding with the capacity value of the condenser being tested, as described below.

MODEL CC

Capacity Range	Attach Cond. to Terminals	For Paper - Mica Conds. Set P.F. Control At	For Electrolytic Conds. Set P.F. Control At	Setting for Switch "S"	Multiply Scale Reading By
.00001- .002 mfd.	Cond.	Paper-Mica	—	CX	.0001 .0001
.001 - .2 mfd.	Cond.	Paper-Mica	—	CX	.01 .01
.10 - 25. mfd.	Cond.	Paper-Mica	Electrolytic	CX	1. 1.
25. -800. mfd.	Cond.	Paper-Mica	Electrolytic	HX	1. 1.

MODEL CB

Test Terminals	Capacity Range Mfd.	Power Factor Control for Paper - Mica	Power Factor Control for Electrolytic	Place S At	To Obtain Capacity
Cond.	.0001- .007	Paper-Mica	—	C2	Read Directly
Cond.	.001 - .7	Paper-Mica	—	C1	Read Directly
Cond.	.10 -200	Paper-Mica	Electrolytic	C3	Read Directly

Rotate capacity control slowly in a clockwise direction from "OPEN" to "SHORT" until a shadow appears in the green light indication given by the 6E5 cathode ray tube. Adjust this control until the maximum shadow angle is obtained. This is the "balance position". Capacity readings are then taken directly.

For electrolytic condensers, balance capacity control first, then adjust Power Factor Control for the maximum shadow angle. Then read the Power Factor directly from this scale.

OFF CAPACITY—Condensers which measure more than 30% lower than rated capacity should be replaced by ones of the correct value. For filter and bypass use, no limit need generally be

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placed on the upper capacity limit. Special cases will be considered later. The capacity of A.C. or motor starting electrolytic condensers should be within $\pm 20\%$ of rated value for satisfactory starting torque. However, a slightly greater tolerance is permissible for some motor applications.

OPEN—Any condenser which can only be balanced at "Open" on the capacity scale after careful adjustments are made with "S" in all capacity positions. (Replace condenser).

INTERMITTENT—Usually an intermittent will test as open or shorted because of the low alternating voltage placed upon it. Occasionally it can be detected by a variation in shadow angle, after the final balance is obtained. (Replace condenser).

HIGH POWER FACTOR—Any condenser for which a balance is not obtained on any position of the power factor control should be replaced. For A.C. or motor starting electrolytic condensers power factors above 20% generally are unsatisfactory. Such condensers should be replaced.

SHORTED—Shorted condensers will balance at the "Short" position of the capacity control for any setting of switch "S" if shorted solidly. There will be no balance obtained if the short is high resistance. Shorted condensers will show up on the leakage test as well.

For most filter applications, quite wide capacity variations are permissible. In some circuits, however, the capacities must be held closely for best results. Some radio receivers utilize tuned choke filter systems; in such cases capacities should be held within plus or minus 10% of specified value. Resonant circuits and band-pass filters generally require that capacitor values be held closely, but the limits must be determined individually for each special case.

In testing condensers of low capacity, about .001 mfd. or below, the leads to the condensers under test must be kept short. Best results will be obtained by plugging the ends of the condenser leads directly into the pin jacks, and if the most accurate results obtainable

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with this instrument are desired, the metal panel of the analyzer should be grounded to the "B.X." line or any convenient ground. This is shown in Fig. 2.

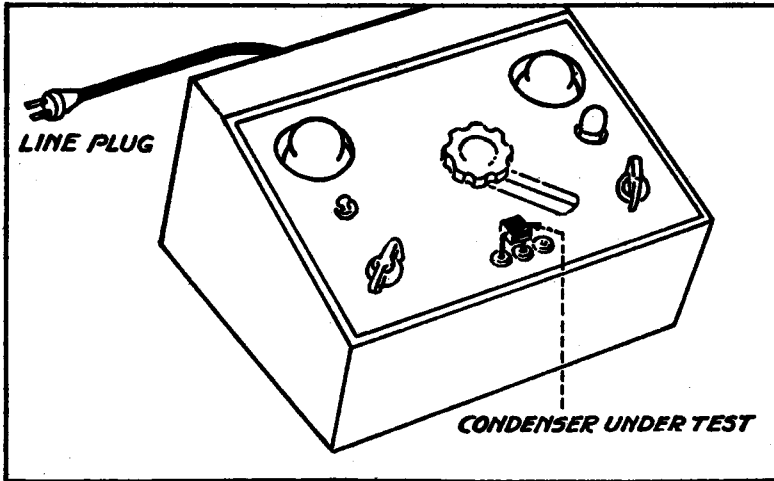


Fig. 2

For ordinary filter use, condensers for which a complete balance may be obtained on any setting of the Power Factor Control will generally be satisfactory, especially in the case of high voltage wet electrolytic condensers.

While for most filter applications high power factors are not of importance, provided they are within the range of the power factor scale of this instrument, some applications require a lower power factor. One such application is met where the electrolytic condensers are used as filters in the power supply and as R.F. bypass condensers at the same time, as in Fig. 3.

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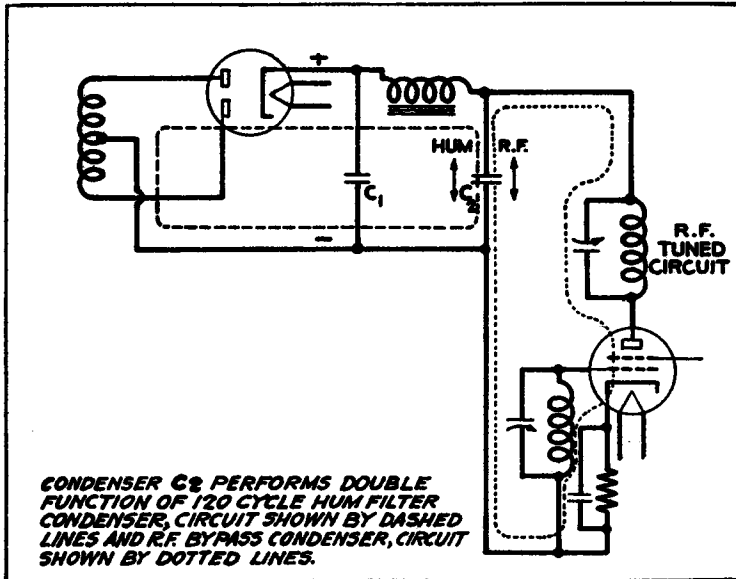


Fig. 3

The power factor must be low enough so that the condenser will not cause R.F. oscillation when used in such circuits. The maximum power factor which can be tolerated in such circuits depends entirely on the particular receiver although in general if the power factor is below 10%, the condenser will be satisfactory for this use.

For applications other than R.F. bypassing, the power factors of electrolytic condensers may run rather high and still give satisfactory service. Some types of condensers, such as high voltage wet electrolytics and etched foil condensers, may be expected to have higher power factors than other types, without being in any respect inferior in operating qualities. For this reason, care must be exercised in drawing conclusions on the basis of power factor measurements.

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The tabular chart below indicates the filtering efficiency of condensers with various power factors. By multiplying the measured capacity of any given electrolytic condenser by the efficiency shown in this chart for a given power factor, the result indicates what capacity in a perfect condenser will replace the electrolytic condenser with the same results in the filter.

During operation A.C. or motor starting electrolytic condensers generally will overheat if the power factor is above 20%. A motor may operate satisfactorily with such a condenser but within a short time will become defective.

POWER FACTOR	FILTERING EFFICIENCY
5%	.999
10%	.995
15%	.989
20%	.980
25%	.968
30%	.955
35%	.935
40%	.915
45%	.895
50%	.867
60%	.800
70%	.715
80%	.600
90%	.436
100%	0

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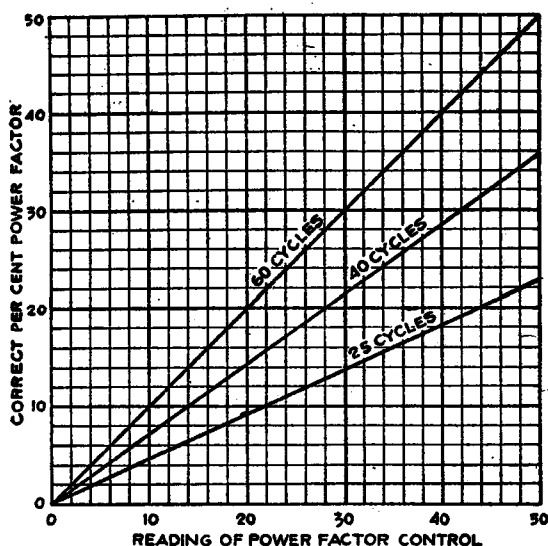


Fig. 4

Power Factor Correction for Line Frequency

The power factor scale of the analyzer is calibrated for measurement at 60 cycles. The export Models CC 2-U and CB 2-U are designed for operation at frequencies from 25 to 60 cycles. The chart in Fig. 4 shows the correction to be applied to the measured values when the measurement is made at 25 and 40 cycles.

RESISTANCE TESTS FOR ALL TYPES OF RESISTORS

Plug tips of the test leads into jacks marked "RES". Connect resistor securely to clips. Proceed with testing by adjusting "S" to suitable range as described below:

MODEL CC

Resistance Range	Attach Resistor to Terminals	Set Switch "S" at	Multiply Scale Reading By
50-7500 ohms	RES.	RX .01	.01
5000-2,000,000 ohms	RES.	RX 1.	1.

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MODEL CB

Resistance Range	Attach Resistor to Terminals	Set Switch "S" at	To Determine Resistance
50-7500 ohms	RES.	R2	Read Directly
5000-2,000,000 ohms	RES.	R1	Read Directly

Rotate large control in a clockwise direction from position "SHORT" to "OPEN" until a shadow appears in the green light indication given by the 6E5 cathode ray tube. Adjust the large control for maximum shadow angle and take resistance readings directly from scale corresponding with setting of switch "S".

The resistance of high inductance choke coils and transformer windings cannot be measured with this instrument, although insulation resistance of such components may be measured by the leakage test.

MISCELLANEOUS APPLICATIONS

In addition to the routine tests previously described, this test instrument may be used for many other applications, in both the laboratory and shop. Some of these uses are enumerated below:

The insulation resistance between coil windings of transformers, wires in cables, terminal strips, etc., may be measured easily. This is done by connecting the test leads from pin jacks "COND" to the devices to be tested. Set the Power Factor Control in position "Paper-Mica," first putting switch "S" in position 4 and Capacity Control at "short". The insulation resistance may be determined from the number of seconds per flash of the "Leakage" Neon lamp by applying the following formula:

N = Number of seconds per flash.

R = Leakage resistance in megohms.

$$R = 30 N$$

To check the insulation resistance of terminal strips one of the test lead clips should be connected to any of the terminals on the strip, the other test clip should be touched to the fibre or other

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insulating material of the terminal strip about $\frac{1}{8}$ " to $\frac{1}{4}$ " from the terminal lug. The resulting flashes of the Neon "Leakage" lamp may be interpreted as described above to determine the leakage.

Continuity tests may be performed with the test instrument by connecting the test leads to terminals "COND". Set switch "S" at position "3" and Capacity Control at "Short". For test of very high resistance circuits set Power Factor Control at "Paper-Mica"; for all other circuits, set this control at electrolytic. This set-up permits rapid circuit tests of radio receivers, and other devices and component parts.

One difficulty which crops up quite often in the field is leakage between sections of multiple unit, positive common (common anode) dry electrolytic condensers. This condition is very difficult to detect with ordinary test instruments but can be checked very easily by means of this test instrument.

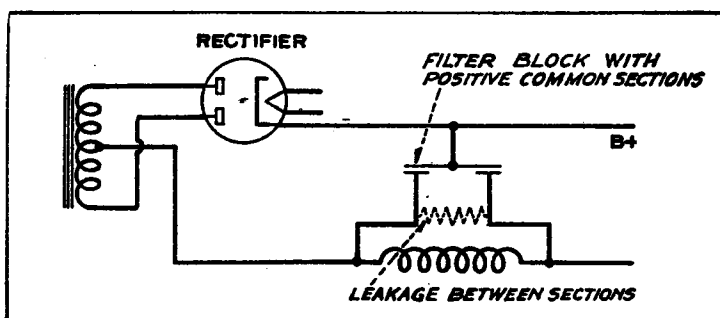


Fig. 5

The circuit shown in Fig. 5 is typical of circuits using positive common electrolytic condensers. Leakage between negatives in this circuit shunts the choke in the negative lead and reduces its effectiveness, thereby increasing the hum level.

This condition may be detected in such units by connecting one of the sections, preferably the one of lowest capacity, to the leakage test terminals "COND" of the test instrument with "S" set at the proper voltage. Measure the leakage in the regular manner and

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MISCELLANEOUS APPLICATIONS (Continued)

with the first section still connected to the test instrument, short together the negative lead of the second section to the common positive connection, as shown in Fig. 6. If there is appreciable leakage between sections, a very noticeable spark will occur every time the leads are shorted together. This test should be repeated several times, allowing about five seconds each time before the leads are shorted. If a slight spark is noticed the first time or after the leads are kept apart for considerably longer periods than five seconds, the leakage between sections may be neglected for all practical purposes.

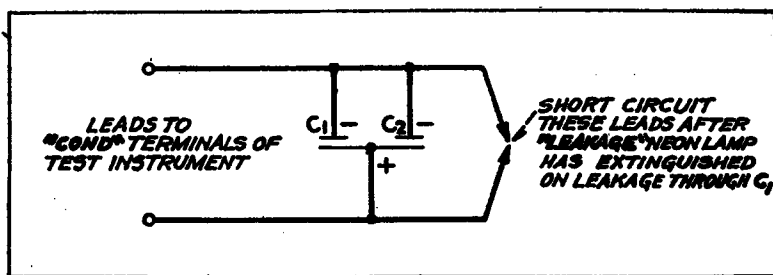


Fig. 6

CARE OF ANALYZER

The Solar Capacitor Analyzer brings to laboratory and the radio service bench the accuracy of the Wien Bridge Method of capacity measurements, greatly simplified. This Analyzer is a precision measuring instrument, and must be treated as such. It is not essentially delicate, like moving-coil instruments, but it is carefully calibrated and pointer settings must not be disturbed. Should the Bridge Control be loosened and require resetting, the Analyzer must be returned to the factory. There is a small charge for this calibration service.

Solar will not supply the type 6E5, "80" or "IV" tubes (except on special export orders).

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The Neon glow-lamps are available at all times through Solar distributors or from the factory.

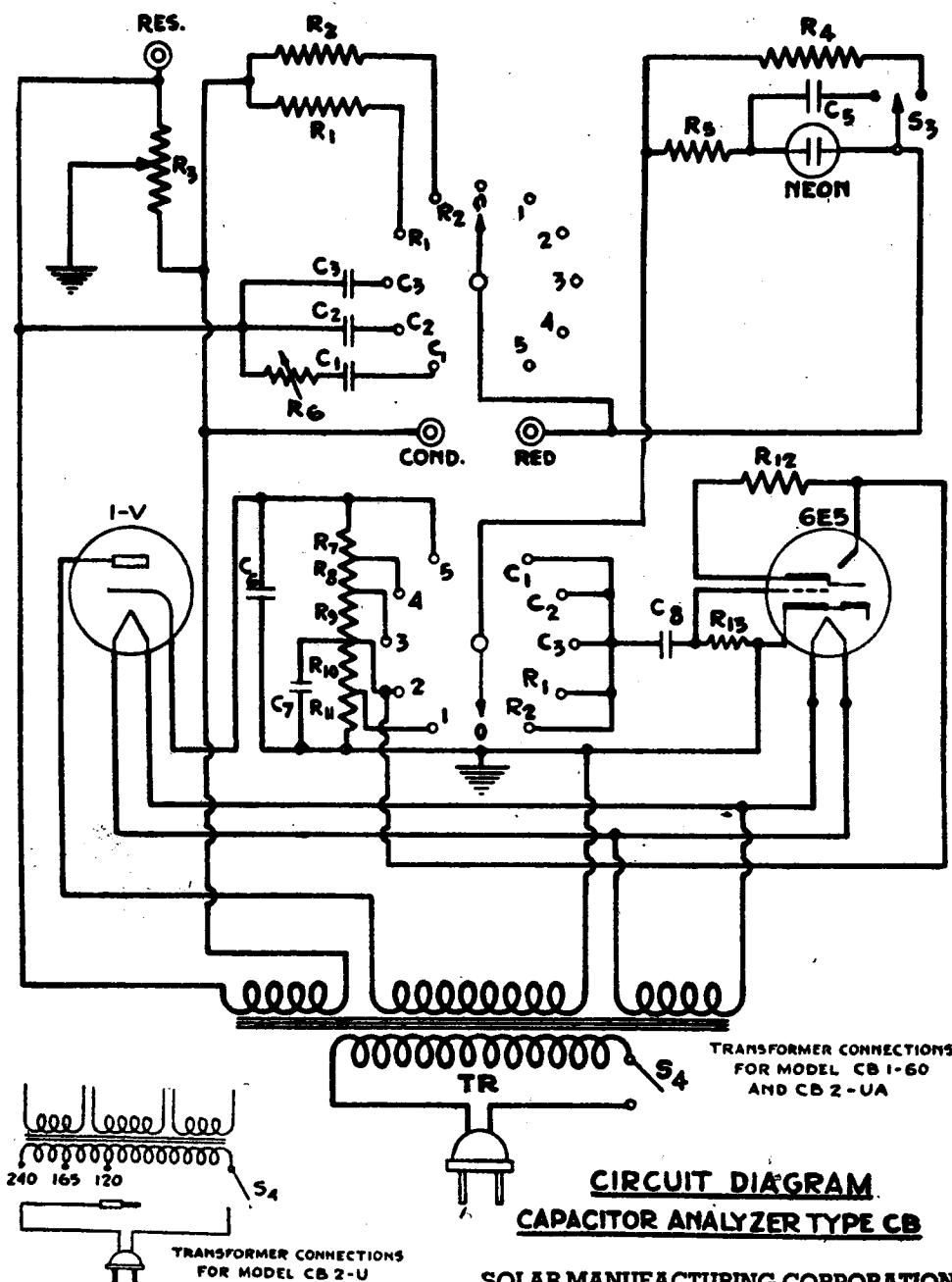
To check the "Leakage" Neon lamp short circuit terminals "COND", place Power Factor Control at "Paper-Mica" and adjust "S" to Position "1". If the line voltage is 110 volts, the Neon should give a steady glow and if no indication is given it should be replaced.

★

GUARANTEE

This Analyzer is guaranteed to perform as described, and to be free from defects in materials or workmanship. Any failure due to faulty materials or workmanship will be corrected without charge, if instrument is returned prepaid to the Solar factory, within 90 days from date of purchase.

Made and guaranteed by
SOLAR MANUFACTURING CORPORATION
Manufacturers of Wet and Dry
Electrolytic, Paper, Mica and
Trimmer Condensers
Bayonne, N. J.



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